Paleoseismic Investigation of the Northern Calaveras Fault at Welch Creek, Alameda County, California

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Investigations

We are conducting paleoseismic investigations of the northern Calveras fault at Welch Creek, in the southern part of Sunol Valley, Alameda County, California. Our efforts this year are a continuation of preliminary trenching studies conducted at the site in 1994. Our primary focus at this site is to determine a late Holocene slip rate for the northern Calaveras fault. Additionally, we would like to constrain the timing of late Holocene surface-rupturing earthquakes, particularly the most recent event.

At Welch Creek, the northern Calaveras fault crosses a pair of fluvial terraces and the intervening terrace riser. In the subsurface, the terrace riser is defined by an approximately 2-m-high bedrock step. We use the base of the terrace riser (e.g., terrace back-edge) as a piercing line with which to determine fault slip rate. We excavated two trenches across the terrace riser on either side of the fault to accurately locate the intercept of the offset piercing line. In addtion, we have excavated a total of three trenches across the fault in order to assess the location and character of the fault, as well as the presence or absence of event-related deposits that may record past earthquakes. We also excavated individual trenches and test pits to assess the presence or absence of secondary fault traces and the nature of stratigraphic relations on both terraces crossed by the fault. Samples of detrital charcoal are currently being prepared for radiocarbon analysis to constrain the ages of the offset terrace back-edge and the deposits overlying it.

Our previous trenching investigations in 1994 resulted in a preliminary estimate of the amount of dextral terrace back-edge displacement of 32 $\pm$ 6 m. Based on broad constraints on the age of the back-edge from limited radiocarbon analysis, we estimated a minimum and maximum slip rate values of 2 $\pm$ 1 and 6 $\pm$ 1 mm/yr for the northern Calaveras fault at the site. In addition, during our 1994 investigation we identified at least five and possibly seven surface-rupturing earthquakes preserved in Holocene deposits.

The purpose of our current investigation is to refine our preliminary results by pin-pointing the amount of terrace back-edge displacement, and improving constraints on the ages of the back-edge and specific event-related deposits. We endured over a year of delays before receiving access permits from the property owner (San Francisco Water Department) to conduct these continuation studies.

Results

Our recently completed group of paleoseismic trenches allowed us to improve our estimate of the amount of displacement of the offset terrace back-edge. We excavated trenches this summer across the back-edge very close to, and on either side of, the fault. These excavations revealed that the back-edge displacement is greater than previously estimated; the amount of dextral offset appears to be on the order of 38 m. The terrace back-edge has now been exposed in four trenches, two on either side of the fault, and its appearance is consistent across the site.

Our recent trenches also allowed us to improve our understanding of the nature of deposition on the younger, inset terrace. The sedimentary cover on the lower terrace consists of (from oldest to youngest) an unknown thickness of gravelly alluvium, about 1 meter of sandy alluvium, and a 1.0- to 1.75-m-thick debris flow deposit. These deposits are consistent across the entire younger terrace surface. We are in the process of preparing structure contour and isopach maps of these deposits in order to assess the source of the deposits observed in the trenches, as well as the timing of depositional events. A clear understanding of these factors will aid our interpretation of earthquake timing at the site.

Event-related deposits associated with the most recent and penultimate earthquakes were identified in a trench across the fault during our recent investigation. These deposits are colluvial deposits that are being shed from an escarpment along the fault formed by juxtaposition of the higher, older terrace and the younger, inset terrace. The penultimate event is represented by a coarse debris-facies colluvial deposit and superjacent fine, wash-facies colluvial deposit. These deposits were faulted during the most recent event, and are buried by an undeformed colluvial layer that presumably post-dates the most recent event. We intend to submit charcoal and bulk soil samples from these deposits to constrain the timing of these two most recent earthquakes.

We collected over 40 charcoal samples from our recent trenches, and are currently preparing the best of these for radiocarbon analysis. Our intent is to use the radiocarbon dates to constrain the age of the terrace back-edge (e.g., piercing line), the timing of deposition on the younger, inset terrace, and the ages of event-related deposits.

Availability of data

Logs of trenches and maps of the site and vicinity are available by contacting G. Simpson at the addresses above.

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We are conducting trenching studies of the northern Calaveras fault in Alameda County, California to assess the late Holocene slip rate of the fault and the timing of past earthquakes. We estimate the rate of recent fault movement by identifying a linear geologic feature that has been displaced by the fault, in this case the back-edge of a river terrace, and carefully measuring the age and amount of offset. Understanding of the past history of earthquakes on the northern Calaveras fault allows us to estimate the probability of future earthquakes on the fault, which poses a significant hazard to the eastern San Francisco Bay region.